United States Environmental Protection Agency **Office of Research and Development**

National Exposure Research Laboratory
Research Abstract

Government Performance Results Act (GPRA) Goal 8
Annual Performance Measure 74

Significant Research Findings:

Produce Land-cover/Land-use Digital Database for Contiguous U.S.

Scientific Problem and Policy Issues	Many of today's environmental problems, such as nutrient pollution, habitat loss, climate change, and urbanization, are regional to national in scale and require land-cover data to study their causes and consequences. Such environmental problems transcend administrative boundaries; national-scale production of the MultiResolution Land Characteristics (MRLC)-National Land Cover Data (NLCD) overcomes a fundamental obstacle that has plagued all previous land-cover mapping efforts — lack of data beyond a given jurisdictional boundary. The MRLC Consortium, of which The U.S. Environmental Protection Agency (EPA) is a member, sponsored the production of the first national-scale, consistently classified NLCD to provide information (land cover) to address these and many other issues. The NLCD provides, free-of-charge through Internet access (http://www.epa.gov/mrlc), generalized land-cover data for the conterminous U.S. (e.g., deciduous forest, evergreen forest; cropland, hay/pasture; high- and low-density residential). The data are widely used within EPA to address issues related to many Government Performance Results Act (GPRA) goals (e.g., 2.2.3 - clean water), and the data are used by many outside EPA.
Research Approach	MRLC-NLCD land-cover mapping had two primary objectives: 1) produce land-cover data for the contiguous U.S., and 2) evaluate the accuracy of that data. The first objective, land-cover mapping for the 1990s, was accomplished using Landsat Thematic Mapper (TM) data collected using a target year of 1992. Conversion of the Landsat TM spectral data to land cover was accomplished using minimum-distance-to-mean Euclidean clustering and post-clustering logical modeling. The post-clustering logical modeling used a suite of ancillary data, including Digital Elevation Models (DEM) and TIGER road and census data. The second objective, evaluation of land-cover thematic accuracy, was accomplished using two-stage cluster sampling. The two-stage sampling design was implemented to meet four criteria of a statistically rigorous sample: 1) satisfy protocols defining a probability sample, 2) provide sufficient sample size for each mapped land-cover class to estimate accuracy with reasonable precision, 3) maintain reasonable cost, and 4) achieve a spatially well-distributed sample.
Results and Impact	Land-cover mapping was completed during the 2001 calendar-year and was made available the through the Internet. The land-cover data can be obtained free-of-

charge at http://www.epa.gov/mrlc. The data are made available by state. In addition, numerous landscape indicators were developed from these data and are Internet-available (http://www.srs.fs.fed.us/4803/landscapes). Thematic accuracy evaluations have been completed for eight of the 10 EPA federal regions, and are in progress for the other two. The accuracy evaluations completed to date indicate that the thematic accuracy of the MRLC-NLCD land cover meet the long-standing nominal standard of 85% agreement (Anderson et al. 1976) at the Anderson Level I thematic detail (e.g., forest, agriculture, urban, water, barren, grass/shrub). At the Anderson Level II of thematic detail, overall accuracies are about 60%. The Anderson Level II land-cover classes are: water, perennial snow and ice, low-intensity urban, high-intensity urban, commercial/industrial/transportation, bare rock/sand/clay, mining, transitional, deciduous forest, evergreen forest, mixed forest, shrubland, orchards/vineyards, "semi-natural" grassland, hay/pasture, row crops, small grains, fallow, open urban areas, woody wetland, emergent wetland.

Research Collaboration and Research Products

EPA's research collaborations can be grouped into three areas: land-cover mapping, accuracy evaluation, and landscape indicator development. U.S. Geological Survey (USGS) EROS Data Center (EDC) is the principal collaborator for land-cover mapping. USGS EDC and Steve Stehman (SUNY-ESF) are the principal collaborators for accuracy assessment, and the U.S. Forest Service is the principal collaborator for landscape indicator development. Relevant research publications are listed below in four categories: program overview and land-cover mapping, accuracy evaluation, landscape indicator development, and applications.

Program overview and land-cover mapping

Vogelmann, J. and Wickham, J. Implementation Strategy for Production of National Land-cover Data (NLCD) from the Landsat 7 Thematic Mapper Satellite. US EPA/600/R-00/051, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC, 2000.

Vogelmann, J., Howard, S., Yang, L., Larson, C., Wylie, B., and Van Driel, N. Completion of the 1990s National Land Cover Data Set for the Conterminous United States from Landsat Thematic Mapper data and ancillary data sources. *Photogrammetric Engineering and Remote Sensing,* 67:650-662, 2001.

Wickham, J., Hegge, K., Homer, C., and Morissette, J. National land-cover database 2000 update. *The Earth Observer,* 14(2):13-15, 2002.

Accuracy evaluation

Smith, J., Wickham, J., Stehman, S., and Yang, L. Impacts of Patch Size and Land Cover Heterogeneity on Thematic Image Classification Accuracy. *Photogrammetric Engineering and Remote Sensing,* 68:65-70, 2002.

Wickham, J., Stehman, S., Smith, J., and Yang., L. Submitted. Thematic Accuracy of MRLC-NLCD land cover for the Great Lakes, Midwest, and Pacific Northwest. *Remote Sensing of Environment.*

Yang, L., Stehman, S., Smith, J., and Wickham, J. Short Communication: Thematic accuracy of

MRLC land-cover for the eastern United States. *Remote Sensing of Environment*, 76:418-422, 2001.

Landscape indicator development

Riitters, K.H., Wickham, J.D., Vogelmann, J.E., and Jones, K.B. National land-cover pattern data. *Ecology*, 81(2): 604 and *Ecological Archives* [www.esapubs.org/archive/ecol/E081/004]., 2000.

Applications

Jones, K., Neale, A., Wade, T., Wickham, J. , Cross, C.., Edmonds, C., Loveland, T., Nash, M., Riitters, K., and Smith, E. The consequences of landscape change on ecological resources: an assessment of the US mid-Atlantic region, 1973-1993. *Ecosystem Health*, 7:229-242, 2001.

Riitters, K., Wickham, J., O'Neill, R., Jones, K., Smith, E., Coulston, J., Wade, T., and Smith, J. in press. Fragmentation of continental United States forests. *Ecosystems.*

Smith, J., Wickham, J., Norton, D., Wade, T., and Jones, K. Utilization of landscape indicators to model pathogen impaired waters. *Journal of the American Water Resources Association*, 37:1-10, 2001.

Wickham, J., O'Neill, R., Riitters, K., Smith, E., Wade, T., and Jones, K. Geographic targeting of increases in nutrient export due to future urbanization. *Ecological Applications*, 12:93-106., 2002.

Future Research

Completion of the first NLCD product was based on Landsat TM data collected on a target year of 1992. Over the next three to five years, the principal emphasis of MRLC-NLCD will be to produce a second land-cover database from Landsat ETM+ collected on a target year of 2000. There are two major methodological changes in the production of the MRLC-NLCD 2000 land-cover data: 1) mapping by ecoregion-like mapping zone and 2) use of decision-tree software for modeling of Landsat spectral data into land-cover classes. In addition there are three research areas supporting MRLC-NLCD 2000 land-cover production: 1) accuracy evaluation of the MRLC-NLCD 2000 land-cover product, 2) sampling design and accuracy evaluation of a level I land-cover change product derived from comparison of the 1992 and 2000 data, and, 3) development and analysis of landscape indicators from the MRLC-NLCD 2000 land-cover data. Collaborators for accuracy evaluation of the 2000 products include the U.S. Department of Agriculture (USDA)-SCS, USGS EROS Data Center, and SUNY-ESF. Collaborators for sampling design and accuracy evaluation of change include SUNY-ESF and USGS EROS Data Center. The USFS is the principal collaborator for development and analysis of landscape indicators. Completion of MRLC-NLCD 2000 is anticipated to be FY2008. The supporting research will be ongoing as data become available for selected regions.

Contacts for Additional Information

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